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Modeling Intertwined Humanity:

Neutrosophic Complete Graphs, Ubuntu, and the *Logic of Not*

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Abstract: The human experience, at its most fundamental level, is one of interconnectedness. No individual exists in isolation; identities are forged, values are shaped, and realities are co-constructed within a complex web of relationships. Yet, traditional Western philosophical and scientific models often emphasize individualism and discrete entities, probably influenced by traditional Aristotelian logic, struggling to fully capture the fluid, ambiguous, and often contradictory nature of these interdependencies. The challenge, then, is to develop a modeling framework capable of expressing such profound and multi-faceted entanglement, especially when relationships are characterized by ambiguity, partial truths, or even co-existing contradictions. Classical graph theory, with its binary edges (either a connection exists or it does not), falls short. This article argues that the **Neutrosophic complete graph**, a powerful extension of fuzzy and intuitionistic fuzzy graph theory, offers a promising mathematical instrument for precisely this purpose. By incorporating degrees of truth, falsehood, and crucially, **indeterminacy** (or neutrality/hesitancy) into its representation of nodes and relationships, the Neutrosophic complete graph can provide a sophisticated and nuanced model for the intertwined humanity perceived in Ubuntu and the complex non-dualistic insights of the "*logic of not*," thereby mirroring the irreducible dependency found in Borromean rings.

Keywords: interconnectedness; intertwined humanity; Neutrosophic complete graph; graph theory

1. Introduction

The human experience, at its most fundamental level, is one of interconnectedness. No individual exists in isolation; identities are forged, values are shaped, and realities are co-constructed within a complex web of relationships. Yet, traditional Western philosophical and scientific models often emphasize individualism and discrete entities, struggling to fully capture the fluid, ambiguous, and often contradictory nature of these interdependencies. This limitation becomes particularly apparent when attempting to understand philosophies that place radical emphasis on relationality, such as

the African life philosophy of Ubuntu or the nuanced "logic of not" as expounded in certain Eastern thought traditions.

Ubuntu, with its celebrated maxim "I am because we are," posits a communal essence where individual personhood is inextricably linked to the well-being and existence of the community. Similarly, a "logic of not," as discussed by thinkers like Shigeki Nagatomo in relation to Japanese philosophy, delves into the non-dualistic nature of reality, where distinction does not imply absolute separation but rather a dynamic interdependence. These concepts challenge binary thinking, hinting at a reality where relationships are not merely "on" or "off" but exist in shades of truth, falsehood, and significant indeterminacy. Such intricate, non-reducible interdependence finds a compelling physical analogy in the Borromean rings, a topological link in which no two rings are directly connected, yet all three are inextricably linked such that removing one causes the others to fall apart. This structure, also observed in chemistry at the molecular level, vividly illustrates irreducible collective dependency.

The challenge, then, is to develop a modeling framework capable of expressing such profound and multi-faceted entanglement, especially when relationships are characterized by ambiguity, partial truths, or even co-existing contradictions. Classical graph theory, with its binary edges (either a connection exists or it does not), falls short. This article argues that the **Neutrosophic complete graph**, a powerful extension of fuzzy and intuitionistic fuzzy graph theory, offers a promising mathematical instrument for precisely this purpose. By incorporating degrees of truth, falsehood, and crucially, **indeterminacy** (or neutrality/hesitancy) into its representation of nodes and relationships, the Neutrosophic complete graph can provide a sophisticated and nuanced model for the intertwined humanity perceived in Ubuntu and the complex non-dualistic insights of the "logic of not," thereby mirroring the irreducible dependency found in Borromean rings. This exploration will delve into these philosophies, introduce the topological analogy, demonstrate the limitations of conventional models, and finally, detail how Neutrosophic complete graphs can serve as a novel and insightful tool for understanding our deeply intertwined existence.

2. Methods

Methods used here are literature review on several ideas that mostly can be found in several cultures, such as Ubuntu and the logic of not of Nagatomo; thereafter we offer a reinterpretation of those classic ideas in connection with mathematical concepts such as Borromean ring and Neutrosophic complete graph. While existing literatures on Borromean ring and Neutrosophic complete graph are quite abundant, we do not discuss articles in particular, only several recent literatures.

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3. Results

Understanding the philosophical underpinnings of intertwined humanity is crucial before attempting to model it. Two distinct yet converging traditions offer profound insights: the African philosophy of Ubuntu and the "*logic of not*" rooted in certain Eastern philosophical discourse, particularly as interpreted by scholars like Shigeki Nagatomo.

3.1. Ubuntu "I am because We are."

Ubuntu is a foundational concept in Southern African philosophy, encompassing a complex array of values, including communalism, interconnectedness, compassion, humaneness, and reciprocity. Its essence is captured in the Nguni proverb, "Umuntu ngumuntu ngabantu," which translates to "A person is a person through other persons" or, more colloquially, "I am because we are."

At its core, Ubuntu posits that human beings achieve their full personhood, their moral and spiritual well-being, not in isolation but through their relationships and participation in the community. It challenges the Western notion of the autonomous, self-sufficient individual, arguing instead that identity and existence are fundamentally relational. A person's humanity is not an inherent quality divorced from others but is actualized and recognized through acts of empathy, generosity, shared responsibility, and mutual respect within the collective.

Key aspects of Ubuntu that highlight intertwined humanity include:

- Communalism over Individualism: The community's well-being takes precedence over individual desires when they conflict. This is not to diminish individual value but to assert that individual flourishing is intrinsically linked to the flourishing of the whole.
- Interdependence: Every individual is understood to be dependent on others for their existence, development, and even their very sense of self. This extends beyond immediate family to the broader community and, in some interpretations, to all of humanity and even the natural world.
- Shared Humanity and Empathy: Ubuntu cultivates a deep sense of shared humanity, where the suffering or joy of one is felt, to some degree, by all. Compassion, kindness, and hospitality are central virtues, as they reinforce the bonds that constitute personhood.
- Restorative Justice: In conflict resolution, Ubuntu often emphasizes reconciliation, healing, and the restoration of fractured relationships within the community, rather than purely punitive measures. The goal is to repair the social fabric that has been damaged.
- Reciprocity and Mutual Obligation: Relationships are characterized by a dynamic flow of giving and receiving. Rights are often framed in the context of responsibilities to others and to the community.

Ubuntu presents a vision of humanity where separation is an illusion, and genuine existence is a co-created, shared endeavor. It emphasizes the inherent potential for connection and the moral imperative to foster those connections for the benefit of all.

3.2. The logic of not (Nagatomo, 2000).

The "logic of not," particularly as discussed by Shigeki Nagatomo (e.g., in his work "Logic of Nothingness and the Essence of Nishida's Philosophy" and other explorations of Japanese Buddhist philosophy, notably the Kyoto School), offers a complementary, though distinct, perspective on

intertwined existence. This concept moves beyond simple binary opposition (A and not-A) to a more profound understanding of negation that reveals interconnectedness rather than absolute separation.

In conventional Western logic, "not-A" is typically the absolute absence or exclusion of A. Nagatomo's work, drawing from figures like Kitaro Nishida and elements of Buddhist thought (especially the concept of *sunyata* or emptiness), explores a "logic of nothingness" where negation is not mere annihilation but a dynamic ground from which distinctions emerge and into which they dissolve, without ultimate, inherent separation.

Key aspects of the "logic of not" that resonate with intertwined humanity:

- **Non-Duality:** The idea that seemingly opposite or distinct entities are not fundamentally separate but are interdependent or derive their meaning from each other within a larger, undifferentiated whole. "Not-A" does not mean A is totally absent, but that A's existence is conditioned by its relationship to "not-A," and vice-versa.

- **Emptiness (Sunyata):** In many Buddhist traditions, emptiness does not mean "nothingness" in the nihilistic sense, but rather the absence of inherent, independent existence (self-nature) in all phenomena. Because nothing possesses an independent self-nature, everything is interconnected and arises dependently. The "not" here signifies this lack of independent being, which paradoxically affirms radical interdependence.

- **Inclusive Negation:** Unlike exclusive negation, this "not" can be seen as an inclusive or encompassing negation, where the "other" is not excluded but rather contributes to the definition of the self. My "not-self" is what allows my "self" to be defined, but this "not-self" is not entirely separate from me.

- **Process-Oriented Being:** Existence is seen less as static, independently defined entities and more as dynamic processes or events that are always in relation. The "not" signifies the fluidity and impermanence that defines this relational becoming.

The "logic of not" thus delves into the philosophical depth of how distinctions and individuality arise *within* an interconnected reality, rather than from absolute separation. It suggests that even the "absence" or "otherness" of something is intrinsically tied to its "presence" or "self," revealing a profound entanglement where boundaries are porous and identities are co-constituted.

Both Ubuntu and the "logic of not" converge on a shared understanding: human existence is fundamentally intertwined. Whether through communal recognition and shared humanity (Ubuntu) or through a non-dualistic understanding of being and non-being (Nagatomo's "logic of not"), these philosophies challenge simplistic, binary views of human connection, underscoring the need for models that can capture this complex, often ambiguous, and deeply relational reality.

4. Applications

4.1. Topological analogy: Borromean rings

To provide a tangible, intuitive metaphor for the non-reducible interdependence articulated by Ubuntu and the "logic of not," we can turn to the fascinating topological structure known as **Borromean rings**. This ancient symbol, found in various cultures and contexts, offers a powerful visual representation of collective dependency where individual pairs are not directly linked.

Borromean rings consist of three (or sometimes more, though the classic is three) closed loops or rings interlocked in such a way that no two rings are directly linked, yet all three are inseparable. The defining characteristic is this: if any *one* of the rings is removed, the remaining two rings immediately fall apart, becoming separate and unlinked. They are not merely linked in pairs, but their collective linkage is emergent from the presence of all three. Their stability is a property of the *system* of three, not of any individual pairwise connection.

The name "Borromean" comes from the Borromeo family of Renaissance Italy, who used the symbol in their coat of arms to signify the unity of their three powerful houses. However, its history predates this, appearing in Norse mythology (often associated with Odin's rings) and Buddhist iconography, symbolizing concepts like the "intertwined nature of existence" or "dependent origination." In Christian symbolism, they have been used to represent the Holy Trinity, emphasizing the inseparable nature of three distinct entities.

Borromean Rings in Chemistry

The relevance of Borromean rings extends beyond abstract symbolism to the tangible world of molecular chemistry. In the field of supramolecular chemistry and knot theory, chemists have successfully synthesized **molecular Borromean rings**. These are mechanically interlocked molecules where three molecular rings are intertwined in precisely the Borromean fashion.

The significance in chemistry lies in the fact that these interlocks are **topological** rather than covalent. That is, the atoms within each ring are covalently bonded, but the rings themselves are held together not by direct chemical bonds between them, but by their *shape* and *arrangement*. Breaking a single bond within one ring can cause the entire system to unravel, even though there were no direct bonds between the other two rings and the one that was broken. This demonstrates:

- **Non-Covalent Interlocking:** The rings are held together by weaker, non-covalent interactions (like hydrogen bonds, pi-pi stacking, or van der Waals forces) during their synthesis, and once formed, by their mechanical inter-looping.
- **Irreducible Collective Dependency:** The integrity of the molecular structure relies on the presence of all three components. Remove one, and the entire topological link collapses. This is a powerful illustration of emergent properties at the molecular scale.

Relevance to Intertwined Humanity

The Borromean ring structure offers a potent analogy for the intertwined humanity described by Ubuntu and the "logic of not":

1. **Ubuntu's Communal Essence:** Just as the stability of the Borromean rings depends on all three, Ubuntu suggests that an individual's personhood and the community's well-being are mutually constitutive. Remove the "community" or the "other," and the "self" (in its full human sense) unravels. No individual can claim complete self-sufficiency; their very being is interlocked with the network of relationships.

2. **Nagatomo's Non-Dualism:** The lack of direct pairwise linking in Borromean rings, combined with their collective inseparability, mirrors the subtle distinctions in non-dualistic thought. Entities are not strictly separate (no direct link) yet are fundamentally interdependent (all three are needed for the link to exist). The "not" in the "logic of not" implies that a discrete entity cannot be fully understood in isolation, but only through its dynamic, often unstated, relationship to everything else. The absence of a *direct* link doesn't mean a lack of fundamental connection.

3. **Irreducible Complexity:** The Borromean rings serve as a reminder that some systems cannot be reduced to their individual components or simple pairwise sums. The complexity lies in the topological arrangement, the "how" of their collective existence. Similarly, human societies, as viewed through Ubuntu or the "logic of not," are complex systems where the whole is greater than, and fundamentally different from, the sum of its parts.

4.2. Neutrosophic complete graph: beyond traditional graph

While a compelling analogy for intertwined humanity, the Borromean rings still operate within a binary framework (linked or unlinked). To model the nuances, ambiguities, and degrees of connection—the very "truth, falsehood, and indeterminacy" inherent in human relationships—we need a more sophisticated mathematical tool. This is where Neutrosophy and Neutrosophic graphs come into play.

Classical graph theory has been a cornerstone for modeling relationships across various disciplines. A classical graph consists of a set of vertices (nodes) representing entities and a set of edges connecting pairs of vertices, signifying a relationship between them. Crucially, in classical graphs, the existence of an edge is binary: either a relationship exists (edge present) or it does not (edge absent). While powerful for many applications, this binary nature becomes a significant limitation when attempting to model the complexities of human relationships, especially those described by philosophies like Ubuntu or the "logic of not."

Limitations of Classical Graphs for Human Interconnectedness:

1. **Binary Relationships:** Human connections are rarely just "on" or "off." We have strong friendships, weak acquaintances, family ties, professional networks, rivalries, and indifferent relationships. Classical graphs cannot express degrees of connection, intensity, or sentiment.

2. **Lack of Nuance in Non-Existence:** If two people are not friends, a classical graph simply shows no edge. But "not being friends" can mean many things: they are strangers, former friends, active adversaries, or simply disconnected. The nuance of non-relationship is lost.

3. **Inability to Model Ambiguity and Uncertainty:** In real life, we are often uncertain about the nature or strength of a relationship. Is a new acquaintance a friend or just a casual contact? Is a ceasefire truly a cessation of hostilities or a temporary lull? Classical graphs have no mechanism to capture this inherent indeterminacy.

4. **No Representation of Partial Truths or Contradictions:** A relationship might be partially true (they are colleagues) but partially false (they are not friends), or even contain contradictory elements (they are collaborators but also rivals). Classical graphs cannot handle such complexities.

To address these limitations, mathematicians developed extensions to classical set theory and graph theory:

Fuzzy Sets and Fuzzy Graphs: Introducing Degrees

Introduced by Lotfi Zadeh in 1965, **fuzzy set theory** allows elements to have a *degree of membership* in a set, rather than simply being a member or not. This degree is represented by a value in the interval [0, 1]. For example, a person can be "tall" to a degree of 0.8.

Building on this, **fuzzy graphs** allow vertices and/or edges to have fuzzy membership values. An edge between two people might have a membership value of 0.7, indicating a "strong friendship," while another might have 0.3 for a "weak acquaintance." This was a significant step towards modeling nuanced relationships.

Intuitionistic Fuzzy Sets and Intuitionistic Fuzzy Graphs: Adding Hesitancy

Developed by Krassimir Atanassov, **intuitionistic fuzzy sets (IFS)** go a step further. For each element, an IFS assigns:

- A **membership degree (μ)**: the degree to which an element belongs to the set.
- A **non-membership degree (ν)**: the degree to which an element does *not* belong to the set.
- An **indeterminacy or hesitancy degree (π)**: the degree of uncertainty or hesitation about whether the element belongs to the set. Crucially, for any element, $\mu+\nu+\pi=1$. The indeterminacy component (π) is what differentiates IFS from fuzzy sets, capturing ambiguity explicitly.

Intuitionistic fuzzy graphs then apply these three degrees to vertices and edges, allowing for a more sophisticated representation of relationships where there might be a degree of connection, a degree of non-connection, and a degree of uncertainty about the connection.

While intuitionistic fuzzy sets were a significant improvement, they still maintained the constraint that $\mu+\nu+\pi=1$. This implies that the truth, falsehood, and indeterminacy are interdependent. However, in reality, these three components can be independent. For instance, the degree to which a statement is true, false, or indeterminate can each be assessed independently, and their sum may not necessarily be 1. This led one of us (FS) to introduce **Neutrosophy** in 1995. Neutrosophy is a new branch of philosophy that studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra. It proposes that every concept, idea, phenomenon, or theory A is associated with its negation ¬A and its neutrality neutA. More broadly, it posits that for any proposition P, there exist degrees of **Truth (T)**, **Indeterminacy (I)**, and **Falsehood (F)**, where T, I, F are independent components (subsets) of the interval [0,1]. Their sum is not necessarily 1; instead, $0 \leq T+I+F \leq 3$.

This framework, where T, I, and F are independent, allows for:

- **Modeling Ambiguity:** A statement can be 0.5 true, 0.4 false, and 0.8 indeterminate simultaneously (e.g., "The economic situation is stable").
- **Dealing with Contradictions:** A concept can be true to some degree and false to some degree at the same time (e.g., a person can be "kind" (T) but also "ruthless" (F) in different contexts, with some indeterminacy (I) about their overall nature).
- **Greater Expressiveness:** It reflects the inherent nuances and complexities of real-world phenomena, including human relationships, where beliefs, perceptions, and realities are rarely black and white.

Neutrosophy provides the logical foundation for **Neutrosophic sets** and subsequently **Neutrosophic graphs**, which are capable of truly capturing the fluid, multi-valued, and often contradictory nature of human interactions, thus paving the way for a more accurate model of intertwined humanity. A neutrosophic graph **assigns truth, indeterminacy, and falsity membership degrees** to each vertex and edge, representing uncertainty (Kandasamy Ilanthenral & Florentin Smarandache, 2014).

Modeling Humanity

The Neutrosophic complete graph emerges as a powerful and nuanced mathematical model uniquely suited to represent the complex, intertwined nature of humanity as envisioned by Ubuntu and the "logic of not," and analogous to the Borromean rings. By extending the classical concept of a complete graph with Neutrosophic values, it allows for a simultaneous representation of connection, disconnection, and ambiguity across all potential relationships.

Defining the Neutrosophic Complete Graph

A **Neutrosophic graph** is a graph where the vertices (nodes) and edges are characterized by Neutrosophic values – that is, each vertex and each edge has associated degrees of **Truth (T)**, **Indeterminacy (I)**, and **Falsehood (F)**, where T, I, F ∈[0,1] and their sum is not necessarily 1.

A **Neutrosophic complete graph** (denoted as KN) is a Neutrosophic graph where every pair of distinct vertices (u,v) is connected by an edge (u,v), and importantly, both the vertices and these edges possess Neutrosophic values. The "complete" aspect signifies that *potential* or *inherent* connections exist between *all* possible pairs of entities (e.g., all human beings), but the *strength, certainty, and nature* of these connections are then defined by their respective (T, I, F) tuples.

- **Vertices (representing individuals/groups):** For each vertex v, we assign a Neutrosophic value (Tv,Iv,Fv).
    - Tv: Degree to which the individual/group possesses a certain attribute (e.g., "humanity," "communal spirit," "identity").
    - Iv: Degree of indeterminacy or ambiguity regarding that attribute.
    - Fv: Degree to which the individual/group lacks that attribute or possesses its opposite.
- **Edges (representing relationships):** For each edge (u,v) connecting two vertices, we assign a Neutrosophic value (Tuv,Iuv,Fuv).
    - Tuv: Degree to which a positive, constructive, or true relationship exists between u and v.
    - Iuv: Degree of uncertainty, ambiguity, or neutrality in the relationship between u and v. This could represent an unformed relationship, a relationship in transition, or a relationship where boundaries are fluid.
    - Fuv: Degree to which a negative, conflictual, or false relationship exists between u and v (e.g., enmity, severe disagreement, or a state of non-connection despite potential).

Modeling Ubuntu with Neutrosophic Complete Graphs

The Neutrosophic complete graph provides an elegant framework for modeling Ubuntu's core tenets:

1. **Inherent Interconnectedness (The "Complete" Aspect):** The "complete" nature of the graph inherently represents the Ubuntu philosophy that all human beings are fundamentally interconnected. Even if two people have never met, Ubuntu suggests a shared humanity that binds them. The Neutrosophic complete graph captures this by presuming an edge

between *all* individuals, but then allows the T, I, F values on that edge to quantify the *realized* or *perceived* degree of that connection.

2. **Degrees of "Ubuntu-ness" (Vertices):** Each individual (vertex) can be assigned (Tv,Iv,Fv) to represent their embodiment of Ubuntu values. A person highly living by Ubuntu would have a high Tv for "communal spirit," low Fv, and low Iv. Someone individualistic or hostile might have high Fv. The Iv could represent someone in a transition, or whose communal spirit is ambiguous.
3. **Nuanced Relationships (Edges):**
    - A strong, compassionate bond (high Ubuntu connection) would be represented by an edge (u,v) with high Tuv, low Iuv, and low Fuv.
    - A conflictual relationship, while still part of the human network, would have a high Fuv for "positive connection," with possibly a low Tuv and low Iuv. The graph acknowledges its existence within the complete fabric.
    - An ambiguous relationship, like two individuals who know of each other but haven't interacted much, could have a high Iuv, reflecting the uncertainty or the potential for a relationship to form (or not). This captures the fluidity and becoming of relationships.
4. **Collective Well-being:** The overall health and "Ubuntu-ness" of a community could be assessed by aggregating the T, I, F values of its constituent vertices and edges. Areas of low T or high F in the graph would indicate areas needing attention for fostering community.

Modeling Nagatomo's "*Logic of Not*" with Neutrosophic Complete Graphs

The "logic of not," with its emphasis on non-duality and the interconnectedness inherent even in distinction or "nothingness," finds a natural home in the Neutrosophic framework, particularly through the **Indeterminacy (I)** component.

1. **Indeterminacy as "Not-Binary":** The "I" value directly models the "not" that is neither simply "true" nor "false" but somewhere in between, ambiguous, or non-binary. A relationship that is "not-A" (where A is a direct, positive link) can be understood not as a strict absence (high F), but as a state of high Iuv. This means the relationship isn't definitively existing as a positive link, nor is it definitively non-existent as a negative one; it's fluid, potential, or undefinable in strict binary terms. This embodies the non-dualistic view where boundaries blur.
2. **Absence as Potential:** If entities are defined by their relation to "nothingness" or "non-being" (as in some interpretations of *sunyata*), then an edge with a high Iuv might signify a

connection that is latent, unactualized, or exists in a realm beyond simple affirmation or negation. It represents the inherent potential for relationships to arise or shift, a dynamic "non-connection" that is nonetheless part of the intertwined fabric.

3. **Contradictory Relationships:** The independent nature of T, I, and F allows for modeling relationships where opposing forces coexist. For instance, a rivalry might have high Tuv for "mutual awareness" or "competitive interaction" but also high Fuv for "cooperation," with some Iuv for the ambiguity of their future. This captures the nuance of how beings are simultaneously "this" and "not-this" in relation to each other.

4. **Borromean Ring Analogy in Neutrosophic Terms:**

    - Consider three vertices A, B, C representing the rings.
    - The edges between any *two* direct pairs (e.g., A-B) would have a very low TAB (no direct link), a very low FAB (they are not actively repelling or separate in the sense of non-existence), and a very high IAB (their direct relationship is *indeterminate* in terms of simple linkage, hinting at an indirect, topological dependency).
    - However, the *overall system* of A, B, and C as a collective (perhaps represented by a hyper-edge or a systemic property of the graph) would have a high TABC for "collective linkage" or "systemic integrity," reflecting that the whole is undeniably linked.
    - If one node (say, A) is removed, the IBC between B and C would transform to a high FBC for "linkage," signifying their definitive unlinking. This dynamic change in Neutrosophic values upon removal of a component directly models the Borromean property.

By allowing for degrees of truth, falsehood, and crucially, indeterminacy, the Neutrosophic complete graph moves beyond the simplistic "linked or not linked" paradigm. It provides a robust and flexible framework to represent the rich, often ambiguous, and intrinsically collective nature of human existence, resonating deeply with the philosophical insights of Ubuntu and Nagatomo's "logic of not."

Challenges and Limitations:

Implementing Neutrosophic complete graphs for modeling intertwined humanity is not without its challenges:

1. **Data Elicitation:** The most significant challenge is how to accurately assign the T, I, F values for vertices and edges in real-world human contexts. This is inherently subjective and complex.

- **Qualitative Data Translation:** How do we translate perceptions, emotions, and nuanced social behaviors into numerical T, I, F values? This would likely involve sophisticated survey instruments, qualitative coding, behavioral observation, and potentially expert judgment.
- **Consistency and Bias:** Ensuring consistency in value assignment and mitigating interviewer/observer bias will be crucial.

2. **Computational Complexity:** For large populations, a complete graph has a very large number of edges (N(N−1)/2). While modern computing can handle this, processing and interpreting the vast amount of Neutrosophic data can be computationally intensive.
3. **Interpretation and Validation:** The meaning of specific (T, I, F) tuples in a social context needs careful, context-specific interpretation. Validating the accuracy of the model's predictions or insights against real-world social phenomena will be essential but challenging.
4. **Dynamic Nature:** Human relationships are constantly evolving. A static Neutrosophic graph provides a snapshot. Developing dynamic Neutrosophic graph models that show changes in T, I, F values over time would add immense value but increase complexity.

Future Directions:

1. **Methodologies for Value Elicitation:** Developing robust, interdisciplinary methodologies for systematically eliciting Neutrosophic values from human subjects, possibly integrating psychology, sociology, and data science techniques.
2. **Software and Visualization Tools:** Creating user-friendly software and visualization tools that can construct, analyze, and display Neutrosophic complete graphs of human networks. This would make the model accessible to researchers and practitioners.
3. **Applications in Specific Domains:** Applying the model to specific contexts, such as family therapy, community development, international diplomacy, organizational change management, or intergroup relations, to test its practical utility.
4. **Integration with Other Theories:** Exploring the integration of Neutrosophic graphs with other theories of social networks, complex systems, or psychological dynamics to create even richer models.
5. **Longitudinal Studies:** Conducting longitudinal studies to observe how Neutrosophic values in relationships evolve over time in response to various internal and external factors.

5. Conclusions

The application of Neutrosophic complete graphs to model intertwined humanity, drawing inspiration from Ubuntu and Nagatomo's proposition of Asian logic, which he terms: the "*logic of not*," offers several profound implications and opens up exciting avenues for future research.

Implications:

1. **A More Nuanced Understanding of Human Relationships:**
    - **Beyond Binary Thinking:** The most immediate implication is the ability to move beyond simplistic "friend or foe," "connected or disconnected" views. It allows for capturing the full spectrum of human interaction, including relationships that are ambivalent, nascent, deteriorating, or subtly influential.
    - **Identifying Hidden Connections and Tensions:** By assigning Neutrosophic values, the model can reveal relationships characterized by high indeterminacy, which might be potential areas for intervention (e.g., to foster connection or resolve underlying ambiguities) or hidden tensions that are not yet overtly conflictual but have a high "falsehood" potential.
    - **Contextualizing Identity:** The Neutrosophic values on vertices can capture the fluid and context-dependent nature of individual and group identity, reflecting how one's "Ubuntu-ness" or sense of self might vary across different relationships or situations.
2. **Enhanced Tools for Conflict Resolution and Peacebuilding:**
    - **Diagnosing Relational Health:** By mapping a community or group using a Neutrosophic complete graph, analysts can identify "hot spots" (edges with high F or I, indicating conflict or deep ambiguity) and "strongholds" (edges with high T, indicating robust positive connections).
    - **Targeted Interventions:** Interventions can be more precisely targeted. For relationships with high F, the focus might be on reconciliation. For high I, the focus could be on facilitating clearer communication or shared activities to reduce ambiguity and potentially move towards higher T or lower F. This aligns well with Ubuntu's restorative justice principles.
    - **Modeling De-escalation:** The model could dynamically track how interventions shift the T, I, F values of edges over time, illustrating the process of de-escalation as falsehood decreases and truth (or a more stable state) increases.
3. **Understanding Social Cohesion and Organizational Dynamics:**

- **Quantifying Social Capital:** The aggregate T values of edges within a network could serve as a quantitative measure of social cohesion or social capital within a community or organization, allowing for comparative analysis and tracking over time.
- **Optimizing Collaboration:** In organizations, understanding the Neutrosophic relationships between teams or individuals can help in forming more effective collaborative groups, identifying communication bottlenecks (high I), or mitigating internal conflicts (high F).

4. **Philosophical and Cultural Sensitivity:**
    - The Neutrosophic complete graph is inherently more attuned to non-Western philosophical constructs that emphasize interconnectedness, non-duality, and ambiguity, providing a mathematical language for concepts previously difficult to quantify or visualize within traditional logical frameworks. It offers a bridge between qualitative philosophical insights and quantitative modeling.

The profound philosophical insights of Ubuntu and Nagatomo's "logic of not" offer a critical lens through which to view human existence: one that emphasizes radical interconnectedness, interdependence, and a reality often transcending binary distinctions. These concepts resonate powerfully with the irreducible collective dependency exemplified by the Borromean rings. However, modeling such intricate, multi-faceted relationships requires a mathematical framework capable of capturing ambiguity, partial truths, and inherent indeterminacy, qualities that elude traditional graph theory.

The **Neutrosophic complete graph**, with its ability to assign independent degrees of Truth, Indeterminacy, and Falsehood to both entities and their relationships, emerges as a uniquely powerful and promising tool. By presuming a universal potential for connection (the "complete" aspect) and then quantifying the nuanced reality of each interaction, it provides a sophisticated language to articulate the "I am because we are" ethos of Ubuntu and the subtle, non-dualistic implications of the "logic of not." It allows us to visualize how individuals and communities are intertwined not merely by direct links, but by a complex web where clarity, ambiguity, and even conflict coexist, forming a collective tapestry where the integrity of the whole depends on the intricate interplay of all its parts, much like the molecular elegance of Borromean rings.

While significant challenges remain in the empirical application of Neutrosophic values to human data, the conceptual power of this approach is undeniable. It provides a much-needed bridge between profound philosophical insights into our shared humanity and the rigor of mathematical modeling. As we navigate an increasingly complex and interconnected world, developing such nuanced tools becomes crucial for fostering deeper understanding, resolving conflicts, and building

more cohesive and resilient societies. The Neutrosophic complete graph represents a vital step towards a more comprehensive and accurate scientific representation of our truly intertwined human existence.

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